WHAT IS CLAIMED IS:

1. A diffraction grating element, comprising:

a transparent plate having a first surface and a second surface that are substantially parallel with one another; and

a diffraction grating which is formed on a first surface side with respect to the second surface and is substantially parallel with the first surface,

wherein, at any temperature within a temperature range -20°C to +80°C, the sum of the rate of change in the period per unit length of the diffraction grating with respect to a temperature change, and the temperature coefficient of the refractive index of a medium that surrounds the diffraction grating element is 0.

2. The diffraction grating element according to claim 1, wherein the diffraction grating is formed on the first surface.

3. The diffraction grating element according to claim 1, wherein the diffraction grating is supported by the first surface.

4. The diffraction grating element according to claim 1, wherein the diffraction grating is formed within the transparent plate.

5. The diffraction grating element according to claim 1, wherein the transparent plate is made of

silica glass to which an impurity has been added.

6. The diffraction grating element according to claim 5, wherein the impurity is any element among Ge, P and B.

7. The diffraction grating element according to claim 1, wherein the transparent plate is made of silica glass or crystallized glass to which an impurity has been added.

8. The diffraction grating element according to claim 7, wherein the impurity is the element Ti.

9. The diffraction grating element according to claim 1, wherein the transparent plate is constituted by laminating a plurality of optical glasses with different linear expansion coefficients.

10. The diffraction grating element according to claim 9, wherein the section of the transparent plate where the diffraction grating is formed is made of silica glass.

11. The diffraction grating element according to claim 9, wherein the distribution of material in the thickness direction of the transparent plate is symmetrical.

12. The diffraction grating element according to claim 11, wherein the diffraction grating is formed in the center in the thickness direction of the transparent plate.

13. The diffraction grating element according to claim 1, wherein the transparent plate is made of silica glass to which an impurity has been added at a different concentration in the thickness direction.

14. The diffraction grating element according to claim 13, wherein the impurity is any element among Ge, P and B.

15. The diffraction grating element according to claim 13, wherein the section of the transparent plate where the diffraction grating is formed is made of silica glass.

16. The diffraction grating element according to claim 13, wherein the distribution of material in the thickness direction of the transparent plate is symmetrical.

17. The diffraction grating element according to claim 16, wherein the diffraction grating is formed in the center in the thickness direction of the transparent plate.

18. The diffraction grating element according to claim 1, wherein the diffraction efficiency is substantially polarization-independent.

19. The diffraction grating element according to claim 1, wherein:

the medium is air; and

the rate of change in the period per unit length

of the diffraction grating with respect to a temperature change is from 0.63×10^{-6}/K to 1.23×10^{-6}/K.

20. A diffraction grating element, comprising:

a transparent plate having a first surface and a second surface that are substantially parallel with one another; and

a diffraction grating which is formed on a first surface side with respect to the second surface and is substantially parallel with the first surface,

wherein:

the diffraction grating element is disposed in air; and

the rate of change in the period per unit length of the diffraction grating with respect to a temperature change is from 0.65×10^{-6}/K to 1.11×10^{-6}/K.

21. The diffraction grating element according to claim 20, wherein the diffraction grating is formed on the first surface.

22. The diffraction grating element according to claim 20, wherein the diffraction grating is supported by the first surface.

23. The diffraction grating element according to claim 20, wherein the diffraction grating is formed within the transparent plate.

24. The diffraction grating element according to claim 20, wherein the transparent plate is made of

silica glass to which an impurity has been added.

25. The diffraction grating element according to claim 24, wherein the impurity is any element among Ge, P and B.

26. The diffraction grating element according to claim 20, wherein the transparent plate is constituted by laminating a plurality of optical glasses with different linear expansion coefficients.

27. The diffraction grating element according to claim 26, wherein the section of the transparent plate where the diffraction grating is formed is made of silica glass.

28. The diffraction grating element according to claim 26, wherein the distribution of material in the thickness direction of the transparent plate is symmetrical.

29. The diffraction grating element according to claim 28, wherein the diffraction grating is formed in the center in the thickness direction of the transparent plate.

30. The diffraction grating element according to claim 20, wherein the transparent plate is made of silica glass to which an impurity has been added at a different concentration in the thickness direction.

31. The diffraction grating element according to claim 30, wherein the impurity is any element among

Ge, P and B.

32. The diffraction grating element according to claim 30, wherein the section of the transparent plate where the diffraction grating is formed is made of silica glass.

33. The diffraction grating element according to claim 30, wherein the distribution of material in the thickness direction of the transparent plate is symmetrical.

34. The diffraction grating element according to claim 33, wherein the diffraction grating is formed in the center in the thickness direction of the transparent plate.

35. The diffraction grating element according to claim 20, wherein the diffraction efficiency is substantially polarization-independent.

36. The diffraction grating element according to claim 20, wherein the rate of change in the period per unit length of the diffraction grating with respect to a temperature change is from 0.80×10^{-6}/K to 0.95×10^{-6}/K.

37. A diffraction grating element, comprising:

a transparent plate having a first surface and a second surface that are substantially parallel with one another; and

a diffraction grating which is formed on a first

surface side with respect to the second surface and is substantially parallel with the first surface,

wherein:

the diffraction grating element is disposed in a hermetically sealed gas or in a vacuum; and

the rate of change in the period per unit length of the diffraction grating with respect to a temperature change is 2.4×10^{-7}/K or less.

38. The diffraction grating element according to claim 37, wherein the diffraction grating is formed on the first surface.

39. The diffraction grating element according to claim 37, wherein the diffraction grating is supported by the first surface.

40. The diffraction grating element according to claim 37, wherein the diffraction grating is formed within the transparent plate.

41. The diffraction grating element according to claim 37, wherein the transparent plate is made of silica glass or crystallized glass to which an impurity has been added.

42. The diffraction grating element according to claim 41, wherein the impurity is the element Ti.

43. The diffraction grating element according to claim 37, wherein the transparent plate is constituted by laminating a plurality of optical

glasses with different linear expansion coefficients.

44. The diffraction grating element according to claim 43, wherein the section of the transparent plate where the diffraction grating is formed is made of silica glass.

45. The diffraction grating element according to claim 43, wherein the distribution of material in the thickness direction of the transparent plate is symmetrical.

46. The diffraction grating element according to claim 45 wherein the diffraction grating is formed in the center in the thickness direction of the transparent plate.

47. The diffraction grating element according to claim 37, wherein the diffraction efficiency is substantially polarization-independent.

48. The diffraction grating element according to claim 37, wherein the rate of change in the period per unit length of the diffraction grating with respect to a temperature change is 1.2×10^{-7}/K or less.